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ABSTRACT

Research relating to the relationship between hemispheric specialization and creativity is explored with particular emphasis on implications for elementary education. Physiological and psychological evidence is examined for the construct that hemispheric specialization means that the two hemispheres of the human brain are specialized for different modes or styles of information processing. Information is provided about a new creativity test which incorporates into its rationale the notion of hemispheric specialization. Finally, recommendations are made about how to achieve desirable cognitive and affective instructional outcomes. It is suggested that teachers should strive to develop in their students both left-hemisphere and right-hemisphere information processing skills; that elementary education programs provide opportunities for guided discovery and nonverbal (visual-motor and tactile) expression; and that teachers should encourage students to generate new and efficient strategies for information gathering, concept formation, and problem solving. (SBH)

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The Hemispheric Specialization Construct: Developmental and Instructional Considerations for Creative Behavior

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Abstract

Hemispheric specialization means that the two hemispheres of the human brain are specialized for different modes or styles of information processing. In this paper, physiological and psychological evidence for this construct is examined. In addition, the relationship between hemispheric specialization and creativity is explored in detail. Information is provided about a new creativity test which incorporates into its rationale the notion of hemispheric specialization. Finally, recommendations are made about how to achieve desirable cognitive and affective instructional outcomes.

Prior to 1950, intelligence tests were used almost exclusively to assess cognitive functioning. In part, the study of creativity came into being and prospered because of the popular belief that there were important cognitive abilities that were not being measured by traditional tests of intelligence. In response to recent discoveries about individual differences in cognitive functioning, theoretical notions about the creative process are now being reevaluated. In particular, the relationship between creativity and the construct of hemispheric specialization is being examined (Bogen & Bogen, 1969; Garrett, 1974; Torrance, Reynolds, Reigel, & Ball, 1977). Simply stated, hemispheric specialization means that the two hemispheres of the human brain are specialized for different modes or styles of information processing.

Comprehensive definitions of the creative process which are compatible with the notion of hemispheric specialization include the following:

> A process of becoming sensitive to problems, deficiencies, gaps in knowledge, missing elements, disharmonies, and so on; identifying the difficulty; searching for solutions, making guesses, or formulating hypotheses about the deficiencies; testing and retesting these hypotheses and possibly

> modifying and retesting them; and finally communicating the results. (Torrance, 1966, p. 8)

For present purposes, it is sufficient to suggest that creativity is the process of generating, implementing, and communicating unique and efficient strategies that are designed to secure information. Most authorities will agree that everyone has the potential to be creative; some of these authorities may go so far as to suggest that everyone has the potential to be creative in many different skill areas. In actuality, however, the creative activities of most people are usually restricted to a few well-defined behavioral domains. For a given individual, these domains may be better identified when information about that individual's characteristic mode of hemispheric processing is made available.

Hemispheric Specialization Construct

Much of the early evidence used to establish a relationship between cognitive processes and hemispheric specialization resulted from observations of the effects of human unilateral brain injuries (Ettlinger, Warrington, & Zangwill, 1957). Damage to the right hemisphere often produced a loss of spatial ability, whereas damage to the left hemisphere resulted in losses of speech and reasoning abilities.

Treatment of serious epilepsy disorders among humans sometimes requires that the brain halves be surgically disconnected by severing the corpus collosum (i.e., the nerve

fibers which "bridge" the two cerebral hemispheres). When the corpus collosum has been severed, there is no way for information to travel from one hemisphere to the other. Thus, these "split-brain" patients can perform certain tasks only if task-relevant information is presented to the appropriate hemisphere (Gazzaniga, 1975; Sperry, 1968). For example, if a split-brain patient is not permitted to see a spoon which has been placed in his left hand, then he will be unable to name the object; however, he will be able to identify the object by touch and discriminate it from other objects. These outcomes occur because language ability is localized in the left hemisphere. Therefore, the patient in question cannot respond verbally to inquiries because information about the object has been transmitted to the right hemisphere only; however, since he "recognizes" the object in his right hemisphere, he is able to tactually identify it.

By restricting the split-brain patient's field of vision it is possible to limit information processing activities to only one hemisphere. When this procedure is employed, data are secured which suggest that the left hemisphere is specialized for abstract, analytical, digital, logical, sequential, temporal, and verbal operations. Thus, the left-hemisphere controls the following basic skills for school achievement: reading, writing, arithmetic calculation, and speaking. The right hemisphere, on the other hand, is

specialized for aesthetic, analogic, concrete, holistic, imaginal, and spatial functions (Bogen, 1975; Gazzaniga, 1975). This hemisphere includes skills pertinent to the "arts" such as the production of music, painting, and sculpture. Further evidence for hemispheric specialization can be found in the results of studies conducted in the following areas: dichotic listening, tachistoscopic image presentation, electroencephalographic responses, conjugate lateral eye movements, and self-report techniques.

Dichotic Listening

An auditory crossover between ear and hemisphere occurs in much the same fashion as the visual crossover between eye and hemisphere. For auditory stimuli, information presented to the left ear is transmitted to the right hemisphere, and vice-versa. After a review of the electrophysiological evidence exploring auditory transmission, Kimura (1967) suggests that the crossed auditory pathways are stronger than the uncrossed. Thus, the dichotic listening technique can be used to determine hemispheric superiority for different kinds of acoustic stimuli. This technique requires that acoustic stimuli be presented simultaneously to the two ears. Semantic characteristics of the stimuli influence how they are processed in a given cerebral hemisphere. For example, linguistic stimuli (digits and words) are processed more accurately when transmitted by the right ear to the left hemisphere; on the other hand, nonlinguistic stimuli (melodies)

are processed more accurately when conducted by the left ear to the right hemisphere (Kimura, 1967).

Tachistoscopic Image Presentation

By means of tachistoscopic techniques, visual data can be presented at variable speeds to either the right or left visual field of the eye. Data transmitted to the right visual field is processed in the left hemisphere and vice versa. White (1972) reviewed 25 experiments in which tachistoscopic techniques had been used. In general, the results of these studies suggest that verbal stimuli are processed more effectively in the left hemisphere, whereas spatial stimuli are processed more effectively in the right hemisphere. More recently, White and Silver (1975) presented verbal stimuli (CVC nonsense syllables) and visual stimuli (grid patterns) tachistoscopically to the left visual field, the right visual field, and concurrently to both fields. Processing accuracy, defined as number of correct stimuli identifications, was highest when the left hemisphere received verbal material and the right hemisphere received spatial material. Along similar lines, Hines (1975) presented verbal material (words) and nonverbal material (ink blot shapes and faces) to the right and left visual fields. He found that the verbal information was processed more accurately when presented to the right visual field (and transmitted, therefore, to the left hemisphere).

Electroencephalographic Responses

Much of the evidence for hemispheric specialization derives from brain-activity data secured by means of electroencephalographic (EEG) techniques. In most cases, EEG data from both hemispheres are recorded while subjects are actively engaged in a cognitive task with their eyes wide open. When these techniques are employed, the alpha band (i.e., 8-13 cycles/sec) usually provides a base line for brain activity. The presence of alpha-level wave lengths implies that the brain is not engaged in complex information processing activities.

When individuals were engaged in mental arithmetic, Butler and Glass (1974) observed that brain-wave activity (above the level of alpha) was higher in the left hemisphere than in the right hemisphere. Likewise, Galin and Ellis (1975) found that individuals who were working on a verbal task (written recall of a text) exhibited more brain-wave activity in the left hemisphere than in the right. In addition, these authors found that the brain-wave activity pattern was reversed for individuals who were involved in a spatial task (reproduction of geometric designs from memory).

Conjugate Lateral Eye Movements

Clinical observation of the conjugate lateral eye movement phenomenon (a shift of both eyes to the right or to the left during problem solving) was first reported by Day (1964).

Subsequently, a body of literature has emerged which relates directionality of eye movement to hemispheric asymmetry. Several writers (Bakan, 1969; Kinsbourne, 1974) have suggested that movement of the eyes to the left indicates right-hemisphere activity; conversely, movement of the eyes to the right indicates left-hemisphere activity. In order to test this hypothesis, eye-movement data has been recorded following the presentation of tasks designed to engage either one hemisphere or the other. For example, a movement of the eyes to the left (indicating right-hemisphere activity) would be expected following a spatial question such as "On the face of a quarter, does George Washington look to his right or to his left?" On the other hand, a movement of the eyes to the right (indicating left-hemisphere activity) would be expected following an analytical question such as "Explain the expression 'a rolling stone gathers no moss'." Studies testing this hypothesis produced inconsistent results. Thus, Kinsbourne (1972) found significant numbers of eye movements in the predicted direction, whereas Ehrlichman, Weiner, and Baker (1974) did not. Methodological differences between the foregoing studies may account for their discrepant findings (Galin & Ornstein, 1974). Alternatively, it may be that certain individual difference variables such as intelligence (McCallum & Glynn, Note 1) and field-independence-dependence (Ehrlichman, 1977) exert an influence on conjugate lateral eye movements. However, until additional evidence becomes available, the notion that

conjugate lateral eye movements reflect hemispheric processing should remain speculative (see Ehrlichman & Weinberger, 1978, for a detailed review of the literature).

Self Report

Creativity tests appear to measure cognitive characteristics that are not assessed by most standardized tests of intelligence. In fact, Torrance (1975) reports that the median correlation (based on 178 different studies) between intelligence tests and his complete battery of creativity tests was quite low (r = .20). Torrance's (1966) tests of creative thinking are comprised of seven activities which measure verbal creativity and three activities which measure figural creativity. It is interesting to note, as Torrance (1975) does, that these tests predict achievement better in areas such as writing than in other areas such as business. One explanation for this finding is that the test battery is better suited to measure verbal fluency and predict basic (traditional) educational skills. Perhaps, a creativity test which incorporates into its rationale the concept of hemispheric specialization may be better suited to predict performance in artistic and nontraditional educational skills.

Many of the physiological techniques used to investigate the hemisphericity specialization construct require technical and specialized equipment and, in some cases, extensive

medical training. For this reason, researchers would welcome a psychological measure that is comparatively easy to administer. Currently, E. Paul Torrance and his colleagues (Torrance, et al., 1977) are developing a promising paper and pencil inventory called Your Style of Learning and Thinking. The scores from this 40-item, self-report questionnaire are used to classify high-school and college-age students as either left-hemisphere dominant, right-hemisphere dominant, or "integrated" in dominance. Individuals in the latter category do not restrict themselves to strategies representative of only one hemisphere. Preliminary reliability, validity, and normative data for this questionnaire are available in a technical manual (Torrance, Reynolds, Ball, & Riegel, Note 2).

Each item of Your Style of Learning and Thinking presents three related mental operations which are attributed to left-, right-, and integrated-hemispheric functioning, respectively. For example, the following item is representative:

A. Prefer use of visualization and imagery in problem solving;

B. Prefer language and analysis of a problem in order to find solutions; and

C. No preference for either method.

Respondents are asked to indicate which of the three operations in each item best describes their own typical behavior.

In the above item, selection of alternative A would be associated with right-hemisphere dominance, selection of alternative B would be associated with left-hemisphere dominance, and selection of alternative C would be interpreted as integrated in dominance.

It is important that efforts to construct and improve psychological measures of hemispheric specialization continue. Diagnostic assessment of students' preferred information processing strategies may enable teachers to (1) capitalize on their students' preferred strategies, and (2) help their students to develop new and efficient (i.e., creative) alternate hemisphere strategies.

Developmental Processes

The infant is essentially a "split-brain" individual because neural fibers connecting the two cerebral hemispheres are not developed before two years of age (Gazzaniga, 1974). Since the infant cannot yet extract meaning from language, a plausible hypothesis is that right-hemisphere processing dominates early life. Hemisphere specialization studies conducted with infants generally support this hypothesis. For example, Turkewitz, Gordon, and Birch (1965) found right-hemisphere specialization in infants for spatial processing. Eighty-eight percent of the newborns in the study positioned their heads so as to expose the left ear and the left visual field to the environment. Crowell, Jones, Kappunial, and Nakagawa (1973) also contend that

infants exhibit greater right-hemisphere than left-hemisphere activity. Similarly, Harris (1975) maintains that the right hemisphere is the "leading hemisphere" in early life; however, in adulthood the left hemisphere tends to be more active.

The establishment of lateral dominance is usually interpreted as resulting from neurological integrity, and is viewed as a positive attribute. However, bidirectionally (i.e., the capacity of processing information with equal skill in either hemisphere) could also be interpreted as a positive characteristic in older children (Bakan, 1971). Those individuals considered well-integrated may reveal no evidence of dependence on one or the other hemisphere. On the other hand, children who rely primarily on one hemisphere may be handicapped when they perform tasks that are better served by the information-processing style of the adjacent hemisphere.

Hemisphere Specialization and Creativity

The relationship between hemispheric specialization and creative behavior has been explicated in several ways. For example, it has been proposed that creative behavior is largely, if not entirely, the product of right-hemisphere activity. This popular position is implicit in many research questions asked about creative behavior: "Is giftedness or creativity related to 'strong' right brain?" (Olson, 1977, p. 119). Occasionally, this position is

stated explicitly: "There is evidence that the right hemisphere is the site of creative thought" (Wheatley, 1977, p. 38). The argument that creative processes are localized in the right hemisphere may stem, in part, from the belief that right-hemisphere skills (e.g., music, painting, and sculpture) are more esoteric than left-hemisphere skills (e.g., reading, writing, and arithmetic computation).

Studies used to support the foregoing position often have methodological difficulties which make it difficult to draw firm conclusions. For example, Harnad (1972) asked reflective questions of twenty individuals, noted their conjugate lateral eye movements, and classified them as either "left movers" or "right movers." The individuals were then administered the Mednick and Halpern Remote Associates Test. Harnad found that left movers scored higher than right movers and concluded "the right or non-dominant hemisphere is somehow involved in creativity (p. 654). Two features of this study render the results and conclusion questionable. First, conjugate lateral eye movements have not been recognized as a valid measure of hemispheric dominance (Ehrichman & Weinberger, 1978). Consequently, there is no assurance that left-movers were engaging their right hemisphere. And second, the creative behavior assessed by the Remote Associates Test is the production of unusual verbal associations. Since this test is verbal in nature, it is probably a poor candidate for

assessment of right-hemisphere activity. The right hemisphere is no doubt involved in the production of creative behavior; however, at this point in time, a conclusion that this hemisphere is the seat of creativity is premature and founded on limited empirical evidence.

In hemispheric specialization studies, an attempt is made to use "pure" tasks which involve one hemisphere while excluding the other. In contrast, many "real world" tasks involve to varying degrees both the left and the right hemispheres. For example, consider activities such as music and painting which usually are associated with the right hemisphere. Analysis and communication of the techniques required to produce a finished product draws heavily upon left-hemisphere abilities (Garrett, 1974). Conversely, it is conceivable that traditional left-hemisphere activities could involve right-hemisphere abilities. In fact, reading (Glynn & Di Vesta, 1977), writing, and arithmetic computation (Wheatley, Frankland, Mitchell, & Kraft, 1978), may sometimes be enhanced by the construction of a schema (gestalt) which ensures that output is organized and well integrated. For these reasons, it may be more useful to focus upon the strategies or processing styles characteristic of each hemisphere rather than upon the kind of task confronted. This approach has been called the process specificity position (Bogen, 1975). This position is reinforced by recent findings of Levy, Trevarthen, and Sperry (1972): "Where the kind of task

being tested could be performed by either the left or right hemisphere, the two hemispheres accomplished the same task by characteristically different strategies."

Implicit in the process specificity position is the notion that both the left and right hemispheres have the potential to generate new and efficient information-processing strategies. That is, both hemispheres can be seats of creativity. Furthermore, strategies characteristic of each hemisphere may interact to produce creative acts. For example, an architect may use right-hemisphere inspiration to generate the framework for a new exterior-design style. In order to effectively communicate, evaluate, and implement particular features or specifications of this style, the architect must engage left-hemisphere processes. These processes are essential for manipulation of the many structural variables which specify the total design concept.

Recent accounts of the creative process have emphasized the interactive effects of right-hemisphere and left-hemisphere strategies. For example, Garrett (1974) describes this interaction in detail:

> The original vision of the right brain is moulded into something that can communicate beyond itself by the technique-wielding capacity of the left brain. In so doing, a physiological harmony occurs as the brain's strengths work together

> (Sperry, 1974) and a psychological sense of wholeness is achieved. (p. 243)

Parnes (1977) also contends "integration of the special abilities of both the left and right halves is required for creativity" (p. 3). In general, the relationship between hemispheric specialization and creative behavior can be summarized in the following way:

> It is becoming increasingly clear that many of the objectives in education and of society can be attained through the kinds of functioning performed by the right hemisphere and that almost all of them could be attained more effectively by using both kinds of functioning .... In creative thinking, it is especially important to understand the specialized functions of the right and left hemispheres, since almost by definition both kinds of functioning are required. (Torrance et al., Note 2, p. 3)

The emphasis the above theorists place on the combinatorial effects of left- and right-hemisphere strategies in the production of creative acts is entirely consistent with the process specificity position defined earlier.

Instructional Practices

It is clear from the foregoing discussion that teachers should strive to develop in their students both left-hemisphere and right-hemisphere information processing

skills. Unfortunately, it is equally clear that our schools have traditionally emphasized left-hemisphere skills. Achievement in these skills, particularly the three "Rs," is the main criterion of success in elementary and secondary schools. Thus, entrance to college is dependent almost exclusively on mastery of these left-hemisphere skills. In elementary and secondary classrooms, right-hemisphere skills receive comparatively little recognition.

Cognitive Outcomes

If an elementary education program is focused primarily on the development of left-hemisphere skills, then the creative potential of students may not be actualized. As a result of "left-hemisphere bias," teachers may encourage students to process data in a mode that is not efficient for them. For example, consider a situation in which fifth-grade students are required to memorize a list of item such as "exports of Chile." Training in verbal mnemonics (e.g., acronyms and rhymes) may prove very helpful to students who have strong left-hemisphere skills; however, mnemonics of this type may not be as effective for students who have superior right-hemisphere skills. In this circumstance, the latter group of students has been penalized because they have been encouraged to process data by means of a strategy which taps their "weak" hemisphere. In order to remedy this situation, training in nonverbal mnemonics (e.g., visual imagery) should be made available to all

students. Nebes (1975) extends this rationale to creativity training: "Perhaps, when people are talking about the inverse relationship between scholastic achievement and creativity, they are really talking about the effect of overtraining for verbal skills at the expense of nonverbal abilities" (p. 13).

Affective Outcomes

If an elementary education program provides reinforcement only for left-hemisphere skills, then students who are governed by their right hemispheres will achieve success less often than their counterparts. As a result, the former will experience frustration which, in turn, could lead to apathy or hostility toward the teacher and the educational process.

Rosenthal and Jacobson (1968) have demonstrated that teachers inadvertently can communicate their performance expectations to students. Thus, it is possible that teachers who believe that left-hemisphere skills are more valuable than right-hemisphere skills may communicate their biases to their students. Those students who have right-hemisphere talents may respond by repressing those talents.

Recommendations

In contrast to the traditional left-hemisphere emphasis of elementary education programs, many theorists (Bogen,

1975; Gazzaniga, 1975; Samples, 1975; Torrance et al., Note 2) advocate that more attention be given to right-hemisphere strategies and skills. In particular, elementary education programs should include laboratory activities that provide opportunities for guided discovery and nonverbal (visual-motor and tactile) expression. In addition, teachers should encourage students to generate new and efficient strategies for information gathering, concept formation, and problem solving. These strategies can engage hemispheres either singly or in combination. Development of these strategies can be fostered by presenting students with open-ended problems which can be solved by a variety of acceptable strategies.

Reference Notes

1. McCallum, R. S., & Glynn, S. M. Hemispheric activity as a function of cognitive task and ability level. Paper presented at the meeting of the Eastern Educational Research Association, Kiawah Island, South Carolina, March, 1979.

2. Torrance, E. P., Reynolds, C., Ball, O.E., & Riegel, T. Revised (October, 1978) norms-technical manual for Your Style of Learning and Thinking. Inquiries should be sent to E. Paul Torrance, Georgia Studies of Creative Behavior, Department of Educational Psychology, University of Georgia, Athens, Georgia.

References

Bakan, P. The eyes have it. Psychology Today, 1971, 4 (3), 64-67 and 96.

Bogen, J. E. Some educational aspects of hemispheric specialization. UCLA Educator, 1975, 17, 24-32.

Bogen, J. E., & Bogen, G. The other side of the brain III: The corpus collosum and creativity. Bulletin of the Los Angeles Neurological Society, 1969, 34, 191-220.

Butler, S., & Glass, A. Asymmetries in the EEG associated with cerebral dominance. EEG and Clinical Neurophysiology, 1974, 36, 481-491.

Crowell, D., Jones, R., Kappunial, L., & Nakagawa, J. Unilateral cortical activity in newborn humans: An early index of dominance. Science, 1973, 180, 205-208.

Day, M. E. An eye movement phenomenon related to attention, thought and anxiety. Perceptual and Motor Skills, 1964, 19, 443-446.

Ehrlichman, H. Field-dependence-independence and lateral eye movements following verbal and spatial questions. Perceptual and Motor Skills, 1977, 44, 1229-1230.

Ehrlichman, H., & Weinberger, A. Lateral eye movements and hemispheric asymmetry: A critical review. Psychological Bulletin, 1978, 85 (5), 1080-1101.

Ehrlichman, H., Weiner, S. L., & Baker, H. A. Effects of verbal and spatial questions on initial gaze shifts. Neuropsychologia, 1974, 12, 265-277.

Ettlinger, G., Warrington, E., & Zangwill, O. A further study of visual-spatial agnosia. Brain, 1957, 80, 335-361.

Galin, D., & Ellis, R. Asymmetry in evoked potentials as an index of lateralized cognitive processes: Relation to EEG alpha asymmetry. Neuropsychologia, 1975, 13, 49-50.

Galin, D., & Ornstein, R. Individual differences in cognitive style: Reflective eye movements. Neuropsychologia, 1974, 12, 367-376.

Garrett, S. V. Putting our whole brain to use: A fresh look at the creative process. The Journal of Creative Behavior, 1976, 10 (4), 239-249.

Gazzaniga, M. Cerebral dominance viewed as a decision system. In S. Dimond & J. Beaumont (Eds.), Hemispheric function in the human brain. New York: John Wiley & Sons, 1974.

Gazzaniga, M. S. Review of the split brain. UCLA Educator, 1975, 17, 9-12.

Glynn, S. M., & Di Vesta, F. J. Outline and hierarchical organization as aids for study and retrieval. Journal of Educational Psychology, 1977, 69, 89-95.

Harnad, S. R. Creativity, lateral saccades and the non-dominant hemisphere. Perceptual and Motor Skills, 1972, 34, 653-654.

Harris, L. Neurophysiological factors in the development of spatial skills. In J. Eliot & N. Salkind (Eds.) Children's Spatial Development. Springfield, Ill.: Charles C. Thomas, 1975.

Hines, D. Independent functioning of the two cerebral hemispheres for recognizing bilaterally presented tachistoscopic visual-half-field stimuli. Cortex, 1975, 11, 132-143.

Kimura, D. Functional asymmetry of the brain in dichotic listening. Cortex, 1967, 3, 163-178.

Kinsbourne, M. Eye and head turning indicates cerebral lateralization. Science, 1972, 76, 539-541.

Kinsbourne, M. Direction of gaze and distribution of cerebral thought processes. Neuropsychologia, 1974, 12, 279-281.

Levy, J., Trevarthen, C., & Sperry, R. W. Perception of the bilateral chimeric figures following hemispheric deconnection. Brain, 1972, 95, 61-78.

Nebes, R. D. Man's so-called "minor" hemisphere. UCLA Educator, 1975, 17, 13-16.

Olson, M. B. Right or left hemispheric information processing in gifted students. The Gifted Child Quarterly, 1977, 21, 116-120.

Parnes, S. J. CPSI: The general system. The Journal of Creative Behavior, 1977, 11, 1-6.

Rosenthal, R., & Jacobson, L. Pygmalion in the classroom: Teacher expectation and pupils' intellectual development. New York: Holt, Rinehart, and Winston, 1968.

Sperry, R. W. Hemisphere disconnection and unit in conscious awareness. American Psychologist, 1968, 23, 733-734.

Torrance, E. P. Tests of creative thinking: Norms-technical manual. Princeton, N.J.: Personnel Press, 1966.

Torrance, E. P. Creativity research in education: Still alive. In I. Taylor & J. Getzels (Eds.), Perspectives in Creativity. Chicago, Aldine, 1975.

Torrance, E. P., Reynolds, C. R., Riegel, T., & Ball, O. Your style of learning and thinking, forms A and B. The Gifted Child Quarterly, 1977, 21, 563-573.

Turkewitz, G., Gordon, E., & Birch, H. Head turning in the human neonate: Spontaneous patterns. Journal of Genetic Psychology, 1965, 107, 143-158.

Wheatley, G. H. The right hemisphere's role in problem solving. Arithmetic Teacher, 1977, 25 (2), 36-39.

Wheatley, G. H., Mitchell, R., Frankland, R. W., & Craft, R. Hemispheric specialization and cognitive development: Implications for mathematics in education. Journal for Research in Mathematics Education, 1978, 9 (1), 20-31.

White, M. J. Cerebral hemispheres serves as two channels for visual information processing. Bulletin of the Psychonomic Society, 1972, 6 (1), 51-52.

White, G., & Silver, A. B. Cerebral hemispheres serve as two channels for visual information processing. Bulletin of the Psychonomic Society, 1975, 6 (1), 51-52.